Once-Through Cooling Alternatives & Potential Measures to Help Minimize Impingement and Entrainment Impacts

Rick York
California Energy Commission

Cooling Alternative
- Dry Cooling -

- Completely eliminates the need for cooling water
- Eight operating dry cooled facilities in California
- Two largest were licensed by Energy Commission - Sutter Power Plant (540 MW) and Crockett (240 MW, on delta shoreline)
- Otay Mesa Project also dry cooled – under construction (inland San Diego County)
- Dry cooling facility with wet/dry hybrid system involving spray enhancement and/or cooling towers can help on hottest days

Dry Cooling Costs & Concerns

- Concerns include higher capital and operating costs compared to recirculating cooling (cooling towers), large size, increased noise, space needs and visual impacts
- Capacity losses are based upon condenser design and size - the larger the condenser, the larger the capital and operating costs, but the lower the capacity losses
- Even with higher costs and capacity losses, projects can be competitive

Cooling Alternative
- Cooling Towers -

- Recirculating cooling with cooling towers can substantially reduce or eliminate the need for seawater for cooling by up to 95%
- Water options: seawater, wastewater effluent, other water sources unsuitable for municipal or agricultural uses

Cooling Towers Costs and Concerns

- Smaller capital cost than dry cooling, but can cost more than once-through cooling and there are efficiency losses and significant amount of water is evaporated
- May be more expensive than once-through cooling (no cost for water), but cooling towers are feasible since majority of inland power plants employ this cooling method
- Other concerns include particulate matter (air quality), visible plume and blowdown disposal

Alternative Cooling Water Supply

- Once-through cooling with wastewater effluent can eliminate the need for ocean water and entrainment and impingement impacts
- Wastewater cooling was proposed for El Segundo Power Project - Hyperion Wastewater Treatment Plant
- Advantages/disadvantages depend upon local conditions, proximity to water supply, water owner willingness to provide water

Employing a power plant cooling strategy that eliminates the need for once-through cooling is obviously preferred, however there are potential measures that may help lessen impingement and entrainment impacts

- *Habitat Restoration/Creation* -

- Implemented for the Moss Landing Power Plant project (2002) - $7 million provided to Elkhorn Slough Foundation
- Current legal challenge in federal court – current regulations allows for habitat restoration under new 316(b) regulations for NPDES permit renewal process
- Habitat restoration/creation OK in California for CEQA analyses/mitigation

Flow Reduction
- Repowering -

- **Repowering** - combined-cycle combustion technology uses less water per kW/hr than a typical steam turbine power plant
  - **Moss Landing Units 6 & 7 – 1,478 MW** capacity requires **600,000 gallons/minute**, while new combined cycle **Units 1 & 2** are capable of 1,060 MW, but only require **250,000 gallons/minute**

Flow Reduction
- Variable Speed Pumps -

- Reduce cooling water intake flows when generating load reduced
- Amount of reduction depends on many variables such as capacity factor, number of pumps available, pump volume and thermal discharge limitations
- Seasonal reductions of cooling water intake – Delta Dispatch system for Pittsburg and Contra Costa power plants has been implemented to protect larval striped bass and utilizes variable speed pumps
- Pittsburg cost for variable speed pumps = $6.7 million
- Flow reduction techniques can reduce entrainment and impingement impacts

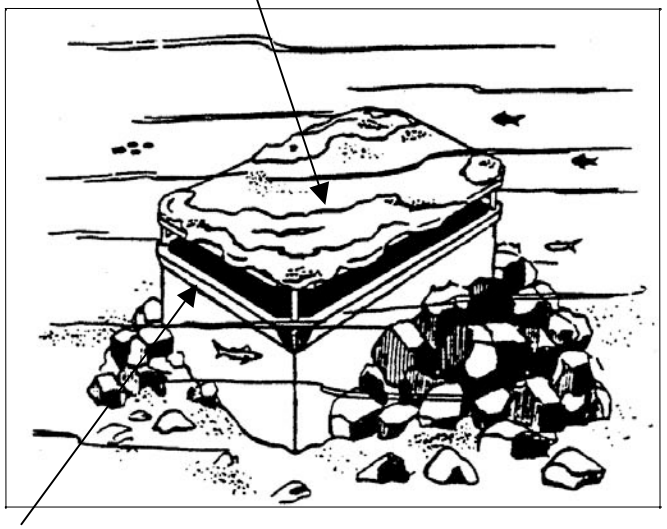
Other Potential Approaches To Help Lessen Impingement and Entrainment

- **Location Options**: intakes in less sensitive environments (offshore in deep water, not in bay or estuary) may be preferable, however could be just trading one problem for another . . .

- **Design/Technology Options – *some work and some don't***
  - Velocity Cap
  - Traveling Screens & Fish Return Systems
  - Cylindrical Wedgewire Screens
  - Aquatic Filter Barriers
  - Behavioral Barriers

Deep Water Intake Velocity Cap

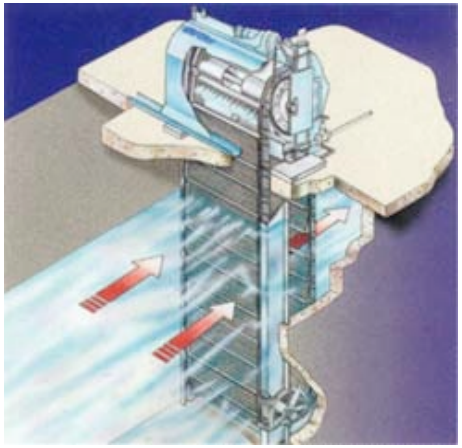
- Shown to reduce impingement 80 - 90% at Huntington Beach
- Common on California power plants with a deep water intake(s)
- Does not reduce entrainment



Water flows horizontally - fish detect horizontal water movement and avoid

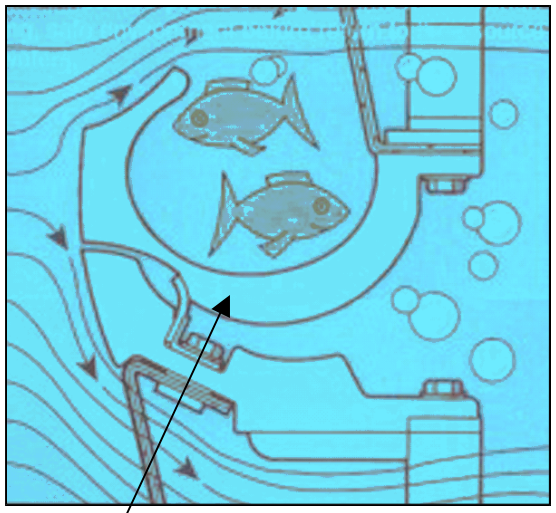
Intake Traveling Screens

- Often located in forebay adjacent to power plant, not at other end of intake
- Standard equipment in California
- Intended to exclude debris but often impinges fish, fish eggs, larvae
- Addition of finer mesh screens and fish return system can reduce impingement impacts and reduce entrainment and allow for easier escape for impinged fish
- Intake flow velocity of 0.5 feet/second (fps) or less through the screen meets impingement performance standard under new Phase II regulations



Traveling Screens & Fish Return Systems

- Fish Return System - San Onofre - $200 million
- Fish return system with traveling screens and fish baskets = Ristroph screen
- Does <u>not</u> address entrainment impacts



Cylindrical Wedgewire Screens

- EPA – Best Technology Available, but only for freshwater river or stream
- Limited application – only deployed in eastern US, none in coastal California
- Concerns: high cost, uncertainty about saltwater deployment
- Addresses impingement and entrainment

Aquatic Filter Barrier

- Gunderboom Inc. *Marine Life Exclusion System*
  - May address impingement and entrainment, however EPA considers experimental only
  - Considered for Contra Costa Power Plant, but determined infeasible
  - Very limited deployment in eastern US
  - Fouling, stability, & high costs are significant concerns
  - Open ocean deployment feasibility study anticipated (El Segundo Power Project)

Other Potential Ways to Minimize Impingement Impacts That Have Had Limited Success

- **Behavioral Barriers** -
  - Sound devices – pneumatic ‘popper’, loud music
  - Lights – mercury vapor lights
  - Bubble curtain
- **Only of limited success** – often species specific and none are currently used

Costs of Alternative Cooling and Potential Impact Minimization Technologies (some numbers from Taft and Cook 2005)

Technology	Capital Cost	O. & M. per year	Eliminates or minimizes impingement & entrainment impacts?
Dry Cooling	$20 - 30 million	variable	Eliminates impacts
Cooling Towers	$10 - 12 million	$2 million	Eliminates impacts if alternative cooling water used; minimizes if ocean water used
Variable Speed Pumps	$6 million (Pittsburg)	variable	Minimizes impacts
Aquatic Filter Barrier	$30 million	$2.3 million	Uncertain, experimental
Behavioral Barriers	$2.6 million	$180,000	Limited successes, species specific
Coarse mesh Ristroph screen	$6.8 million	$546,000	Helps lessen impingement, but not entrainment
Fine mesh Ristroph screen	$10.9 million	$609,000	Helps lessen impingement, but not entrainment
Fixed panel screen	$3.8 million	$251,000	Helps lessen impingement, but not entrainment
Narrow slot wedgewire screen	$25.2 million	$640,000	May significantly reduce impingement and entrainment, of limited use
Wide slot wedgewire screen	$2.6 million	$163,000	Minimizes impingement and entrainment
Velocity cap	$8.6 million	$42,000	Minimizes impingement only

Summary

- Alternative cooling methods can greatly reduce or eliminate impingement and entrainment impacts, however there are increased costs and concerns
- Cooling alternatives are being used and are feasible
- Flow reduction can be an effective way to reduce impingement and entrainment impacts
- Various other devices have been tried, but few have proven to be feasible and/or effective
- Habitat compensation/restoration is a mitigation option